Joint CMS-CALICE Test Beam 2015 Analysis

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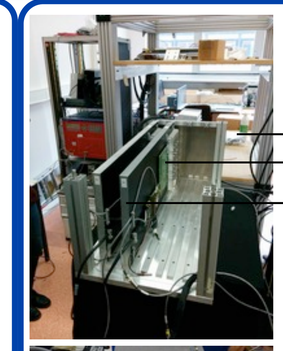
ABSTRACT: A preliminary study using CALICE Silicon-Tungsten (Si-W) modules is presented. Current CMS Endcap calorimeter detectors will be replaced by High Granularity Calorimeter (HGC) and has electromagnetic and hadronic sections. The electromagnetic section consists of 28 tungsten and copper plates interleaved with silicon sensors as the active material. The hadronic part has a front section of 12 brass and copper plates interleaved with silicon sensors. The design of HGC is based on CALICE concept. Thus, the motivation of this study is to understand this detector and its properties in collaboration with CALICE and use the experience gained for the CMS specific detector module and in the corresponding test-beam activities.

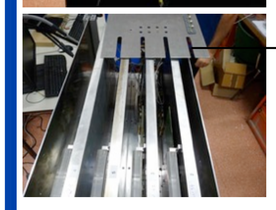
Experimental Setup and Goals

- 4 Layers Si-W ECAL test (the last layer was not operational and was not used)
- Position of Layers: Beam -> Dif 1, Dif 2, Dif0
- Each wafer has 4(chips) x 256 pixels (channels)
- Test of basic setup/electronics/DAQ system mainly.
- Physics commissioning using:
  - proper running with high intensity muons.
  - various scans with different energy electrons/ muons/pions at different positions.
- Look at the pedestal stability
- Calibration using MIPs and study electron response.

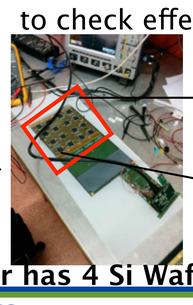
Full Setup at CERN



Si-W ECAL test box
Each Si readout layer
Aluminum Support



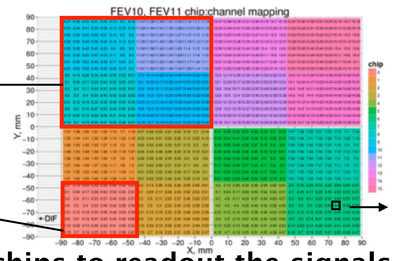
From these gaps on top, W was inserted to check effect of absorber



325 μm thick Si Wafer (9×9 cm^2)

Si Layer Layout

Chip



Single Pixel/Channel

Complete setup placed in test beam area along with the data acquisition system.

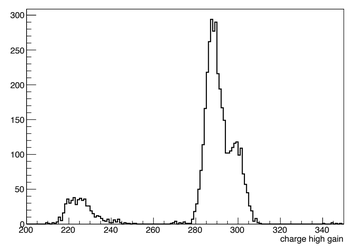
Full setup after the assembly

One such layer has 4 Si Wafers, 1024 cells and 16 chips to readout the signals.

Data Description

- Muon data is being looked at to first study pedestals and MIPs.
- Corresponding to each chip, there are 15 memory buffers (SCA).
- Data is stored in nutples. ADC counts are stored per chip per SCA per channel.
- If a particular channel is fired (230 ADC) within a chip, all the 64 channels within that chip are read.

First look at the Data



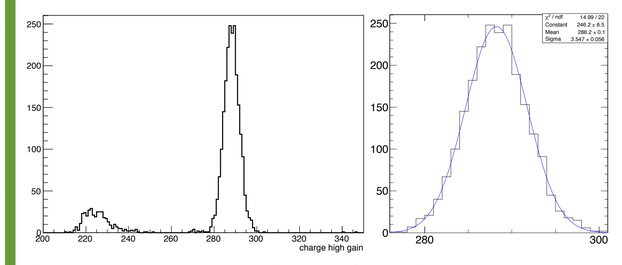
Here, ADC counts are plotted for one of the muon runs for a given chip, a given buffer and a particular channel.

Three distinctive peaks appear here corresponding to different effects.

Different peaks and features

- Each peak distinctively shows 3 different features of negative signals, pedestals and re-triggering effect.
- Negative signals are understood to be coming from some "pick-up noise" but not known in detail.
- Pedestals is the noise affecting the given channel
- Re-triggers are understood to be coming from finite duration of OR of 64 channels with extended duration to next bunch-crossings.

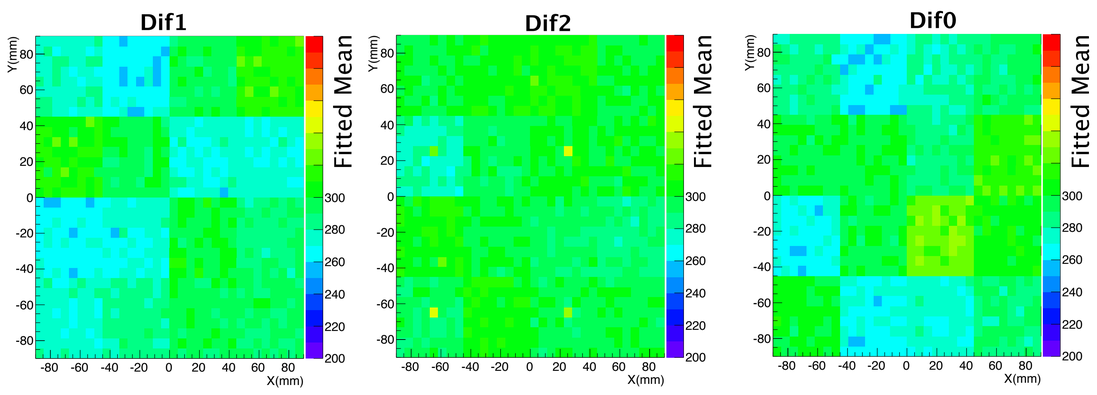
Pedestal Extraction



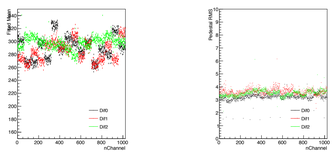
Once, events are cleaned up from re-triggering effect, pedestal distribution on the right is fitted with gaussian to extract the pedestal mean and rms.

- Done for all the channels for each layer

Pedestals for all 3 layers



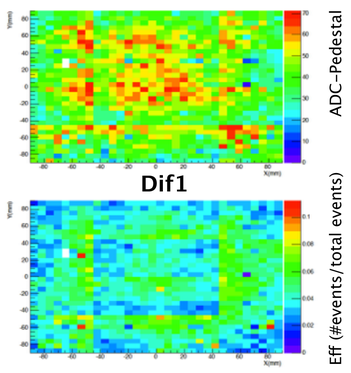
- Plotted here for a muon run in first buffer.
- X, Y here is the position of the channels and z axis gives us the reported mean of gaussian for all the channels.



Pedestal mean and RMS stability across all the channels for different layers

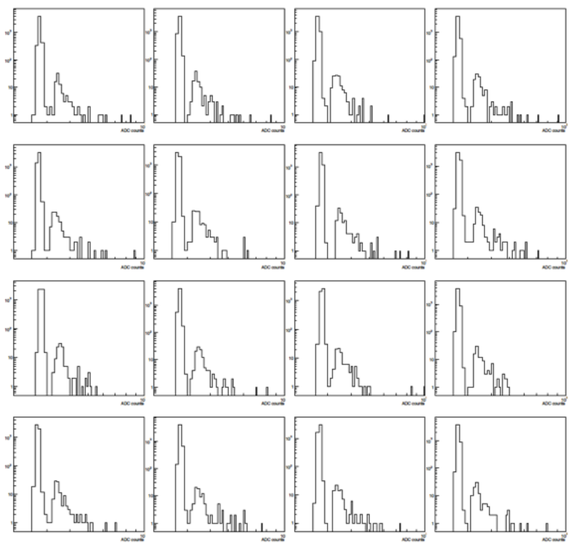
Signal Extraction

Having the information of the pedestal, we move forward to look for the MIP signal from muon run.



Along with the MIP signals, more current near the edges of the chips. Probably effect of the guard ring - to be understood.

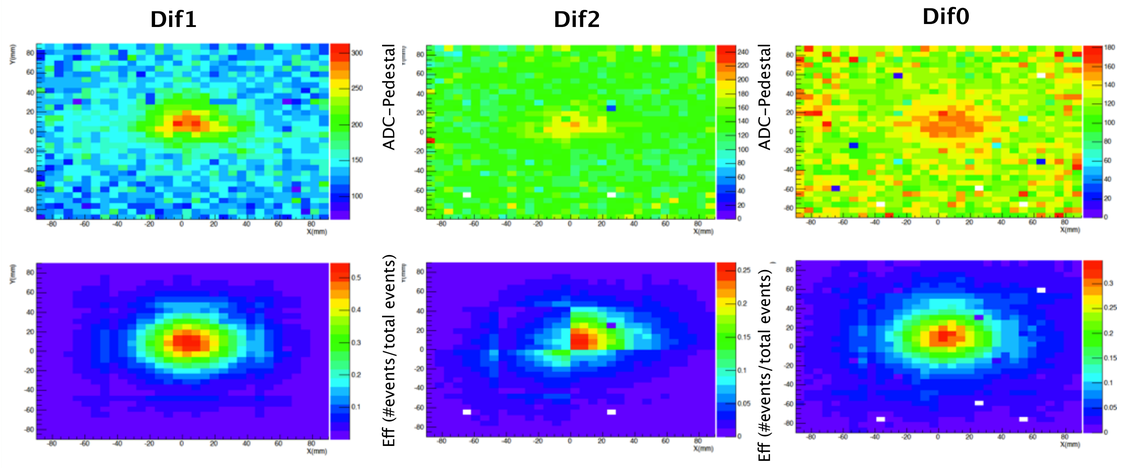
RAW ADC distribution for few channels in chip 12 for Dif1 in Muon Run



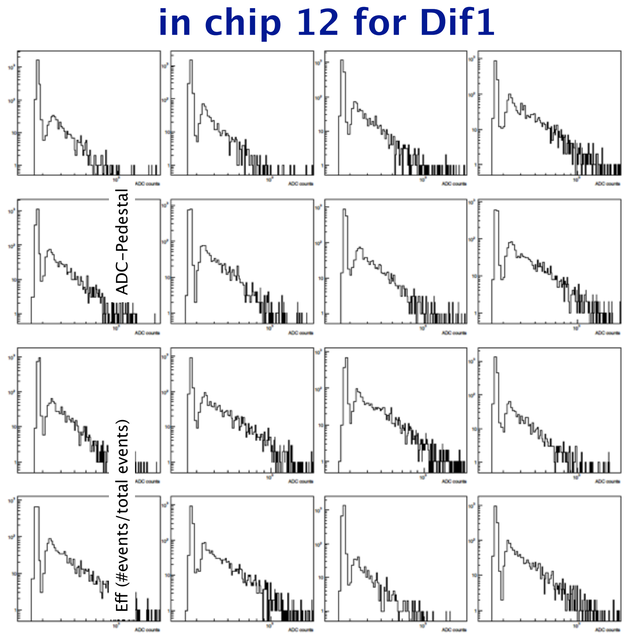
Nicely separated MIP signals from the pedestals

First look at electron data

Having a look at the MIPs, we move forward to look for electron signals. Criteria to have a signal : 10 sigma away from pedestal (took reported mean and sigma of the gaussian for each channel).



ADC distribution for few channels in chip 12 for Dif1



Conclusions and outlook

- MIP signal seen well separated from the pedestals
- Understand the features near the edges of chips
- Look at the electron response in detail.
- First test beam data with 1 CMS specific HGC Electromagnetic calorimeter module has just taken place at Fermilab. Analyze its data.
- Build up experience from these TB analysis and contribute to a full CMS module test coming up in May and later half of the year.